

THREE DIMENSIONAL USER INTERFACE EFFECTS ON A DISPLAY

BACKGROUND

[0001] It's no secret that video games now use various properties of motion and position collected from, e.g., compasses, accelerometers, gyrometers, and Global Positioning System (GPS) units in hand-held devices or control instruments to improve the experience of play in simulated, i.e., virtual, three dimensional (3D) environments. In fact, software to extract so-called "six axis" positional information from such control instruments is well-understood, and is used in many video games today. The first three of the six axes describe the "yaw-pitch-roll" of the device in three dimensional space. In mathematics, the tangent, normal, and binormal unit vectors for a particle moving along a continuous, differentiable curve in three dimensional space are often called T, N, and B vectors, or, collectively, the "Frenet frame," and are defined as follows: T is the unit vector tangent to the curve, pointing in the direction of motion; N is the derivative of T with respect to the arclength parameter of the curve, divided by its length; and B is the cross product of T and N. The "yaw-pitch-roll" of the device may also be represented as the angular deltas between successive Frenet frames of a device as it moves through space. The other three axes of the six axes describe the "X-Y-Z" position of the device in relative three dimensional space, which may also be used in further simulating interaction with a virtual 3D environment.

[0002] Face detection software is also well-understood in the art and is applied in many practical applications today including: digital photography, digital videography, video gaming, biometrics, surveillance, and even energy conservation. Popular face detection algorithms include the Viola-Jones object detection framework and the Schneiderman & Kanade method. Face detection software may be used in conjunction with a device having a front-facing camera (or other optical sensor(s)) to determine when there is a human user present in front of the device, as well as to track the movement of such a user in front of the device.

[0003] However, current systems do not take into account the location and position of the device on which the virtual 3D environment is being rendered in addition to the location and position of the user of the device, as well as the physical and lighting properties of the user's environment in order to render a more interesting and visually pleasing interactive virtual 3D environment on the device's display.

[0004] Thus, there is need for techniques for tracking the movement of an electronic device having a display, as well as the lighting conditions in the environment of a user of such an electronic device and the movement of the user of such an electronic device—and especially the position of the user of the device's eyes and/or head. With information regarding lighting conditions in the user's environment, the position of the user's eyes and/or head, and an instantaneous (or continuous) 3D frame-of-reference for the display of the electronic device, virtual 3D depictions of the objects on the device's display may be created that are more appropriately drawn for the user's current point of view with respect to the device's display.

SUMMARY

[0005] The techniques disclosed herein use various position sensors, e.g., a compass, a Micro-Electro-Mechanical

Systems (MEMS) accelerometer, a GPS module, and a MEMS gyrometer, to infer a 3D frame of reference (which may be a non-inertial frame of reference) for a personal electronic device, e.g., a hand-held device such as a mobile phone. Use of these position sensors can provide a true Frenet frame for the device, i.e., X- and Y-vectors for the display, and also a Z-vector that points perpendicularly to the display. In fact, with various inertial clues from an accelerometer, gyrometer, and other instruments that report their states in real time, it is possible to track the Frenet frame of the device in real time, thus providing an instantaneous (or continuous) 3D frame of reference for the hand-held device. Once an instantaneous (or continuous) frame of reference of the device is known, the techniques that will be disclosed herein can then either infer the position of the user's eyes and/or head, or calculate the position of the user's eyes and/or head directly by using a front-facing camera or other optical sensor(s). With an instantaneous (or continuous) 3D frame-of-reference for the display and/or the position of the user's eyes and/or head, more realistic virtual 3D depictions of graphical objects on the device's display may be created and interacted with.

[0006] To accomplish a more realistic virtual 3D depiction of the objects on the device's display, objects may be rendered on the display as if they were in a real 3D "place" in the device's operating system environment. In some embodiments, the positions of objects on the display can be calculated by ray tracing their virtual coordinates, i.e., their coordinates in the virtual 3D world of objects, back to the user of the device's eyes and/or head and intersecting the coordinates of the objects with the real plane of the device's display. In other embodiments, virtual 3D user interface (UI) effects, referred to herein as "2½D" effects, may be applied to 2D objects on the device's display in response to the movement of the device, the movement of the user (e.g., the user's head), or the lighting conditions in the user's environment in order to cause the 2D objects to "appear" to be virtually three dimensional to the user.

[0007] 3D UI Effects Achievable Using this Technique

[0008] It is possible, for instance, using a 2½D depiction of a user interface environment to place realistic moving shines or moving shadows on the graphical user interface objects, e.g., icons, displayed on the device in response to the movement of the device, the movement of the user, or the lighting conditions in the user's environment.

[0009] It is also possible to create a "virtual 3D operating system environment" and allow the user of a device to "look around" a graphical user interface object located in the virtual 3D operating system environment in order to see its "sides." If the frame of reference is magnified to allow the user to focus on a particular graphical user interface object, it is also possible for the user to rotate the object to "see behind" it as well, via particular positional changes of the device or the user, as well as user interaction with the device's display.

[0010] It is also possible to render the virtual 3D operating system environment as having a recessed "bento box" form factor inside the display. Such a form factor would be advantageous for modular interfaces. As the user rotated the device, he or she could look into each "cubby hole" of the bento box independently. It would also then be possible, via the use of a front-facing camera or other optical sensor(s), to have visual "spotlight" effects follow the user's gaze, i.e., by having the spotlight effect "shine" on the place in the display